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LOGISTICS STUDIES OFFICE

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PROJECT NUMBER 905

METHODOLOGY FOR REAL TIME FORECASTS OF THE

SUSTAINABILITY OF SELECTED MAJOR ITEMS

APRIL 1980

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U.S. ARMY
LOGISTICS MANAGEMENT CENTER
FORT LEE, VIRGINIA
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19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

No automated methodology currently exists which is capable of forecasting the wartime and peacetime consumption of spares and repair parts (Class IX supplies) by major item/weapon system in real time. This void makes it impossible to perform a major item sustainability study quickly enough for the results to be useful during crisis management. The study examines commodity-oriented data files and explains how these files can be converted

20. ABSTRACT (Cont'd): to a major item/weapon system-oriented applications file suitable for computing consumption by major item/weapon system in real time. The applications file could also be used to (1) update Class IX peacetime failure factors to bring them into alignment with actual demand history, (2) compute Authorized Stockage Lists and Prescribed Load Lists based either on peacetime or wartime, (3) document Class IX budget requirements by major item/weapon system, and (4) forecast weights and cubes for movement of Class IX supplies.

METHODOLOGY FOR REAL TIME FORECASTS OF THE

SUSTAINABILITY OF SELECTED MAJOR ITEMS

LOGISTICS STUDIES OFFICE

PROJECT NUMBER 905

FINAL REPORT

APRIL 1980

BY

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ABSTRACT

No automated methodology currently exists which is capable of fore-
casting the wartime and peacetime consumption of spares and repair
parts (Class IX supplies) *by major item/weapon system in real time.*
This void makes it impossible to perform a major item sustainability
study quickly enough for the results to be useful during crisis manage-
ment. The study examines commodity-oriented data files and explains
how these files can be converted to a major item/weapon system-oriented
applications file suitable for computing consumption by major item/
weapon system in real time. The application; file could also be used
to (1) update Class IX peacetime failure factors to bring them into
alignment with actual demand history, (2) compute Authorized Stockage
Lists and Prescribed Load Lists based either on peacetime or wartime,
(3) document Class IX budget requirements by major item/weapon system,
and (4) forecast weights and cubes for movement of Class IX supplies.

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

1. <u>Authority for the Study</u>. Letter, DRCPA-S, HQ DARCOM, 6 February 1979, subject: Request for Logistics Studies, and Inclosure 1-B thereto.

2. <u>Problem Statement</u>. No automated methodology exists today that is capable of rapidly forecasting those quantities of major items which will become Not Operationally Ready Supply (NORS) for lack of adequate repair parts. The principal reason for this void is that wartime and peacetime consumption of repair parts cannot be forecast *in real time by major item/weapon system*.

3. <u>Objective</u>. This study was undertaken to devise machine processes by which data can be extracted from the files of the Commodity Command Standard System (CCSS), purified as necessary, and reformatted in such a way as to permit *real time* Class IX consumption forecasts *by major item/weapon system*.

4. <u>Limits and Scope</u>. The study examines existing DARCOM management systems and data files to determine how they can be used to forecast Class IX consumption by major item/weapon system. The basic information needed to forecast Class IX consumption, in terms of the major items to be supported, is now collected and stored in several separate data files within the management systems used for major and secondary items.

5. <u>Methodology</u>. The Class IX Consumption Forecast Computation Model is described. Major item density data can be made available and, for

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wartime forecasts, scenario factors and time periods for support
are given. Usage data for each part can be extracted from the
National Stock Number Master Data Record (NSNMDR) of the CCSS files
to show:

> End Article Application (EAA) Code
> Part National Stock Number (NSN)
> Related Data Elements and Factors

The End Article Application (EAA) code can be converted to NSN through
use of a cross-reference file. By comparison with a tailored version
of Supply Bulletin 700-20 (Army Adopted/Other Items Selected for
Authorization/List of Reportable Items), the data can be purified of
EAAs which are not currently authorized major items and an increased
usage factor for wartime computations can be added *by major item/weapon
system*. The end result is a *computational* or *applications file* useful
for real time consumption forecasts by major item/weapon system.

6. <u>Findings</u>. Such a *computational* file might also find use in (1)
updating peacetime failure factors to align them with actual demand
history, (2) computing Authorized Stockage Lists (ASLs) and Prescribed
Load Lists (PLLs) based on either peacetime or wartime, (3) documenting
Class IX budgetary requirements by major item/weapon system, and
(4) forecasting weights and cubes for movement of Class IX supplies.

7. <u>Conclusions</u>. The programming effort required to implement the
Study 905 methodology is simple and straightforward; however, the
data files upon which the methodology operates must be reasonably
complete and error free. Although the study did not address the

latter aspect, a clean-up effort could be rather extensive.

8. <u>Recommendations</u>. The next steps, if approved, are development of functional specifications, a cost/benefit analysis, and a resource requirements estimate for implementation.

MAIN REPORT

1. <u>The Problem</u>. No automated methodology exists today that is capable
of rapidly forecasting those quantities of major items which will
become Not Operationally Ready Supply (NORS) for lack of adequate repair
part stocks within the supply system. Typical questions which remain
unresolved are:

1.1 If the US Army supplies country "A" with 1,000 armored personnel
carriers for counter-insurgency operations, what will be the country's
NORS rate at various points in future time? What effect will this have
on US readiness? What changes would be effected if Military Standard
Requisitioning and Issue Procedures (MILSTRIP) priorities applying to
country "A" were changed?

1.2 What are the forecast NORS rates for the Army's essential major
items assuming peace? Assuming war in one theater? Assuming war in
more than one theater?

1.3 How much additional readiness can be purchased for $1 billion,
and into which appropriations should the money go?

1.4 Is the current high level of interest in tanks, helicopters,
and other high visibility weaponry creating potential repair parts
shortages for commonplace items like forklifts and ammunition carriers?

2. <u>Objectives</u>.

2.1 The original study objective, which will subsequently be
revised, was:

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To develop an automated methodology permitting a rapid determination of whether a specified force can be sustained in a given situation. The supportability aspects will be oriented to DARCOM-selected major items of equipment. Given the size and composition of the force, the area of deployment, and the length of the operation, the goal is to establish a DARCOM capability to respond to a question of sustainability within a matter of hours.

2.1.1 Several comments are needed regarding this original objective. *Automated methodology*, as stated above, indicates computer simulation of supply. *Supportability aspects* include all supplies--major items and their replacements, ammunition, fuel, repair parts, etc. *Oriented to... major items* imposes a requirement to do the simulation by National Stock Number (NSN), so that specific makes and models of equipment can be forecast to be in a NORS condition. *Matter of hours* implies a system useful in crisis management.

2.1.2 Initial research was directed toward investigating the Total Logistics Readiness/Sustainability (TLR/S) procedures, since the objectives of this study and TLR/S appeared similar. The TLR/S is a computer-assisted manual exercise designed to evaluate readiness and to support the Program Objective Memorandum. TLR/S addresses maintenance and transportation in addition to materiel supportability aspects. Improvements are constantly being made in TLR/S. In 1980, the major item coverage has increased from 110 items to 130 items and the process of applying assets to requirements has been refined. Analysis of the TLR/S methods and data requirements led to the conclusion that within the near time frame all materiel aspects of TLR/S, except for Class IX materiel (spares

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and repair parts), can be automated to provide real time answers for sustainability questions for a wide range of major items.

3. Background.

3.1 Prior to and during World War II, a form of systems management prevailed within the Army wherein each responsible technical service procured the major item and stocked its supporting parts. Users submitted requisitions using catalog numbers unique to the responsible technical service. The system was reasonably effective in relating demand for parts to the major item for which the part was required; however, because the Federal Catalog System proved itself to be practical and because of the excessive management and materiel costs associated with the old style of item management, a shift to commodity management (one item, one manager) was initiated. This shift was essentially complete by 1970, except for fine tuning which continues even today.

3.2 The benefits of commodity management are enormous; however, the relationship between demand for a part and the supported major item has been obfuscated except for those parts having only one end item application.

3.3 Parts are requisitioned by Army supply and maintenance organizations for two reasons: (1) to repair deadlined major items, and (2) to fill a stockage objective. It might be practical to capture accurate data relating a deadlined major item to a demand for a part, but it is doubtful that materiel ordered for stock could ever be successfully related to the major items for which the materiel is eventually used.

3.4 During the time of initial provisioning, the Materiel Readiness
Command (MRC) having responsibility for the major item builds an NSN
Master Data Record (NSNMDR) for every stock numbered part used within the
major item unless such a record already exists at the MRC for the part.
If this is the case, the usage of the part in the new major item is
recorded as an additional End Article Application (EAA) in Sector 18 of
the existing NSNMDR. There is one notable variation in this procedure
in that not all MRCs build NSNMDRs for the parts used in hidden components.

3.5 If at this point in time the MRC had entered the NSN of each
part into an automated data file, the NSN of the major item upon which
the part is used, and the appropriate usage factors, the Army would have
in existence a file capable of computing Class IX requirements by weapon
system. The capability would exist to sort by major item or to sort by
part in order to accomplish any level of computation necessary.

3.6 Since this is not the case, this study's objective as revised
by the sponsor is:

> *To devise machine processes which can filter out the desired
> data from the files of the CCSS and create an* applications *or*
> *computational file.*

The data therein can then be sorted for computation of requirements by
major item; and if desired, the results can be consolidated to the
weapon system level.

4. Limits and Scope.

4.1 The study examines existing US Army Materiel Readiness and

Development Command (DARCOM) management systems and data files to determine how they can be used to forecast Class IX consumption by weapon system/major item.

4.2 The basic information needed to determine Class IX requirements during peacetime and wartime, in terms of the major items to be supported, is now collected and stored in several separate data files within the management systems used for major and secondary items. *The problem is to create a program which will relate forecasted repair parts consumption to the major items to which the consumption pertains.*

5. <u>Assumptions</u>. Repair parts consumption correlates directly with maintenance skills and capacities and with increases in the operating hours of the major items. For example, consumption will decrease if maintenance personnel do not have either the time or skill to replace those repair parts which fail. To promote as much simplicity as is practical in a study designed to aid the development of a sustainability simulation, the following parameters must be assumed:

5.1 The wartime/peacetime usage ratios (X-Factors or X-FAC) are realistic and include considerations of the ammunition supply rate and the availability of fuel; ergo, gun tubes and fuel burners will indeed receive additional usage in a combat theater as forecast by application of the X-Factor.

5.2 There will be no shortages of either maintenance capabilities or capacities. Repair parts which fail will be quickly replaced unless a replacement part is not available.

6. <u>The Class IX Consumption Forecast Computation Model</u>.

6.1 The model which can be used to forecast Class IX consumption is:

CONSUMPTION = (END ITEM DENSITY) x (PEACETIME FAILURE FACTOR) x
(TIME INTERVAL) x (X-FACTOR) x (INTENSITY FACTOR)

6.2 The model is described narratively as follows: The average density of those major items being used must be known for each time period of the forecast. For each major item (by NSN), the density of the item is multiplied by a peacetime failure factor for every part used therein and divided by 100 (since the failure factor represents failures per hundred major items per year). Further, the number of annual part failures is adjusted to yield the number of failures per scenario time frame (usually 15 or 30 days). This result is multiplied by an X-Factor, which in essence represents the ratio of wear-and-tear during continuous wartime usage to wear-and-tear during peacetime usage. The product represents that quantity of parts forecast to be consumed when the equipment is in wartime usage for 24 hours every day during the scenario time frame. Last, this figure is multiplied by an intensity factor (never more than 1.00), which in essence is the ratio of time in which the equipment is in wartime usage to total time (in-use time plus not-in-use or in-reserve time). The intensity factor relates consumption to the wartime scenario. The final figure is the number of parts which will be consumed by a major item (weapon system per se or weapon system principal component) during a specified scenario time interval. A more comprehensive model which can be used to determine peacetime consumption or both peacetime and combat consumption is explained in Appendix C.

6.3 The following data is required to exercise the consumption forecasting model:

        Major item average in-use densities by NSN by time interval.
        Intensity factors.
        Scenario time frames.
        Failure factors.
        X-Factors
        Relationships between parts and major items.

6.4 The required data can be synthesized as described below: Major item density data is presently computed by the US Army Depot Systems Command (DESCOM) for peacetime in the Total Army Equipment Distribution Program (TAEDP) products and for wartime in the TLR/S density cards. Intensity factors and time frames are furnished by the Office of Secretary of Defense/Department of the Army (OSD/DA). Failure factors and relationships between parts and major items are available within the NSNMDR maintained as part of the Commodity Command Standard System (CCSS) at each MRC. X-Factors are developed by MRC maintenance managers for use in TLR/S. CCSS files express major item relationships in terms of MRC-unique codes; usage records are duplicated by the MRC managing the used part and the MRC managing the major item in which the part is used; and CCSS files contain only an "average" X-Factor for parts having multiple applications rather than X-Factors oriented to individual weapon systems. Research to date has not produced any methodology for forecasting consumption by weapon system through computation using CCSS files directly. Of further note is that CCSS files are addressed by NSN requiring about 25 milliseconds per disk access. On this basis, 144,000 NSNs could be

input per hour; a process too slow to be considered real time. What is needed is a separate file containing standardized codes and factors so that the disk head, upon each access, can pick up a large number of usage records. The US Army Missile Command (MICOM) and DESCOM were revisited for the purpose of collecting information and data necessary for the development of a Class IX requirements computation system. Magnetic tapes of the Standard Study Number System (Supply Bulletin 710-1-1) and essential Class IX items (Army Master Data File (AMDF) extract) were obtained together with a hardcopy of some CCSS data from MICOM. A magnetic tape of the Supply Bulletin 700-20 (Army Adopted/ Other Items Selected for Authorization/List of Reportable Items) was available from a previous Logistics Studies Office (LSO) study. Figure 1 graphically displays the consumption forecasting model.

7. Detailed Methodology.

7.1 Study Approach. This study attempts to identify a methodology to extract, reformat, and purify the data required by the consumption forecasting model from the various automated logistics management (data) systems.

7.2 End Item Density. The methodology to determine end item density already exists in the TAEDP. It converts force and deployment data (peacetime) into the basis for a peacetime distribution simulation. The same methodology can use wartime factors and wartime force/deployment data to provide end item density by NSN. So, the methodology for obtaining the first element in the consumption formula is available.

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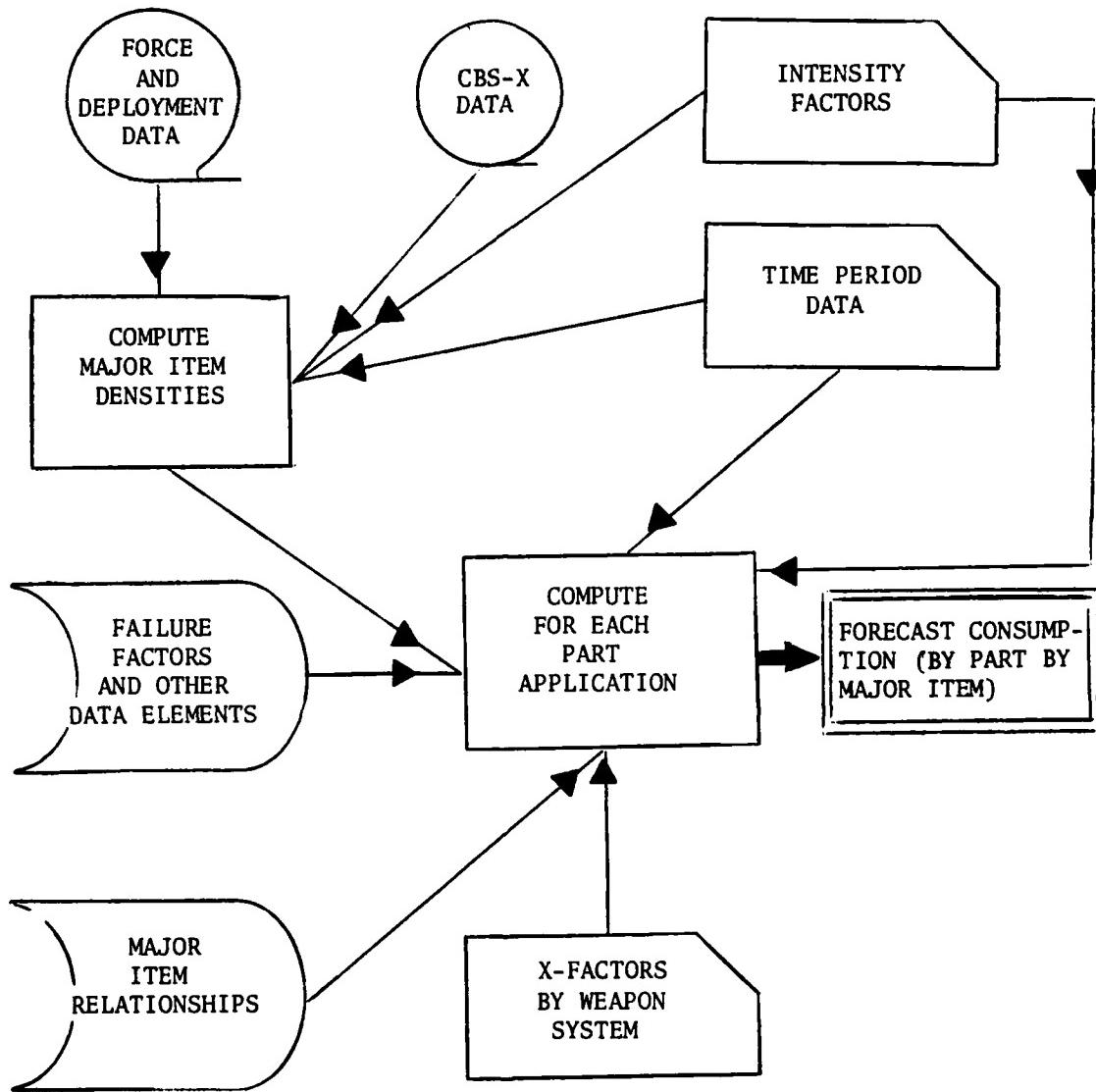
Figure 1

CONSUMPTION FORECASTING MODEL

7.3 <u>Intensity Factors</u>. Since the intensity factors are given by higher headquarters, provision must be made to incorporate them into the consumption computation program, preferably by including them with the end item density data since the same factors apply both to major items and to parts. For a peacetime consumption computation, see Appendix C.

7.4 <u>Time Period</u>. The time period is likewise given by higher headquarters and should be considered when the end item density data is prepared. The program for computing consumption should take the time period data from the end item density data so that both the major items and parts are computed on the same time frames.

7.5 <u>Relating Repair Parts to End Items</u>.

7.5.1 One of the principle difficulties lies in the area of relating repair parts to the end items on which they are used. The available relationships data are contained in the NSNMDR files of the CCSS which are maintained at the various MRCs. These files are used by item managers in coordinating activities with managers of the end item and with main-tenance managers. There are other uses such as the preparation of the Support List Allowance Cards. The end item usage is normally indicated by an EAA coding structure that is unique to the command which manages the files. The CCSS was designed as a business applications sytem, and it is very effective for the business of managing materiel; however, access to Class IX data and conversion of the unique EAA codes to NSNs cannot be done quickly enough to provide real time answers in a crisis.

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7.5.2 There is another complicating procedure. If the part is not to be managed by the same MRC which is to manage the major item, the application data is also furnished to that command designated to manage the part, where either a new NSNMDR is created or the additional application is added to an already existing record. Therefore, the machine processes needed to build a computational file must also delete duplicate applications data or doubling of requirements will be the result. (See Figure 2.)

7.5.3 On occasion, an MRC will use the major item NSN as the EAA code in Sector 18 of the NSNMDR, but more frequently MRC-unique codes are assigned with a cross-reference file (EAA-to-NSN) available for either on-line use, off-line use, or both. These unique codes fall into one of four categories:

7.5.3.1 EAA code relating directly to the major item NSN.

7.5.3.2 EAA code relating to a family of major items in which all factors pertaining to the EAA code apply equally to every major item member of the EAA family. These families may or may not equate to Line Item Number (LIN) groupings or Standard Supply Number (SSN) groupings.

7.5.3.3 EAA code relating to some higher assembly which is not a major item. Inclusion of such a code does not exclude the entry of the major item application. Indeed, the major item application must be included or a serious data disconnect will result.

7.5.3.4 EAA code relating to a manual file (to be called a *pseudo-EAA-code*). This code informs the reader and the computer that

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```
┌─────────────┐                         ┌─────────────┐
│ MAJOR ITEM  │                         │    PART     │
│  MANAGING   │                         │  MANAGING   │
│    MRC      │                         │    MRC      │
└─────────────┘                         └─────────────┘
       │                                       ▲
       │                                       ┆
       ▼                                       ┆
    ╱──────╲                                   ┆
   ╱  PART  ╲                                  ┆
  │  USAGE   │                                 ┆
   ╲  DATA  ╱                                  ┆
    ╲──────╱                                   ┆
       │                                       ┆
       ▼                                       ┆
┌─────────────┐      ╱──────╲      ┌─────────────┐
│             │     ╱  PART  ╲     │             │
│ NSN MASTER  │────│  USAGE   │───▶│ NSN MASTER  │
│ DATA RECORD │     ╲  DATA  ╱     │ DATA RECORD │
│             │      ╲──────╱      │             │
└─────────────┘                    └─────────────┘
```
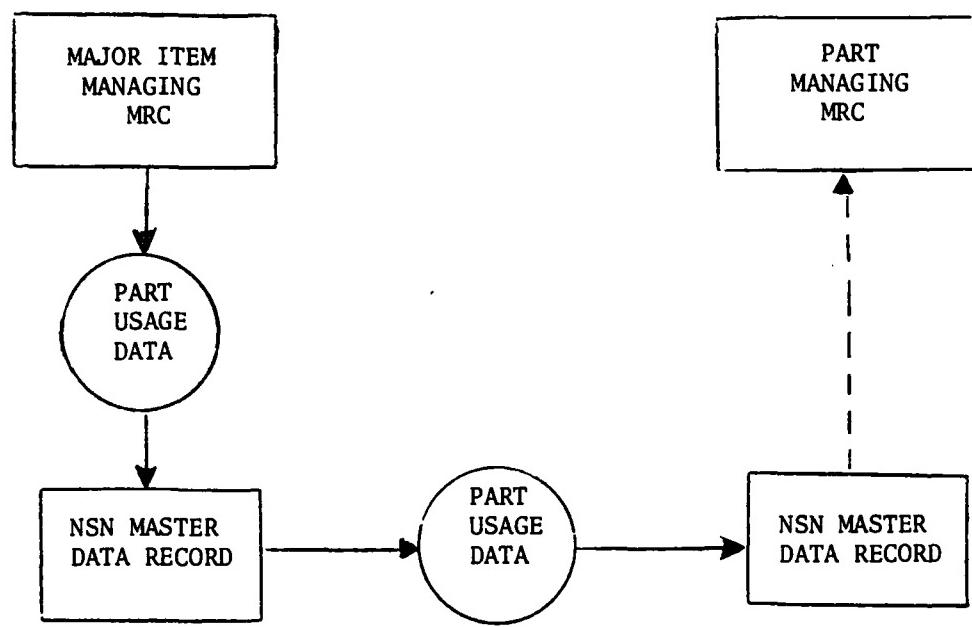
Figure 2

FLOW OF USAGE DATA, WHERE MAJOR ITEM MANAGER
IS NOT MANAGER OF A USED PART

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the EAAs are so numerous as to cause file overflow in NSNMDR Sector 18; therefore, no EAA codes have been placed in this sector.

7.5.4 It is axiomatic that any data processing application which can be done manually can also be done by computer. To convert EAA codes into NSNs requires that the already existing cross-reference files be incorporated into an MRC-unique *translator program*. These MRC *bridging programs* are necessary to span the gap between nonstandard (unique EAA codes) data and standard (NSN) data; additionally, these programs permit the MRCs to continue to use the EAA coding methods and procedures best suited to the commodity managed. This study <u>does</u> <u>not</u> address the possibility of standardizing EAA coding structures and procedures across MRCs. A MICOM translator program would be applied only to MICOM files, US Army Tank Automotive Materiel Readiness Command (TARCOM) translator program only to TARCOM files, etc.

7.5.4.1 For EAA codes which relate to only one NSN, the translation would be straightforward replacement. For instance:

```
  EAA-CODE /  PART-NSN   /   APPROPRIATE DATA
  ABCDEFGHIJ/1234012345678/#######################
```

After an overlay would appear:

```
  EAA-NSN   /  PART-NSN   /   APPROPRIATE DATA
  3210011234567/1234012345678/#######################
```

(NOTE: The EAA code is translated to an EAA-NSN).

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Since some commands include next higher assemblies in their usage files, the EAA-NSN is not necessarily the NSN of a major item.

7.5.4.2 For *family* type EAA codes, the translator must create a new record for every NSN within the family. For example:

```
EAA-CODE /  PART-NSN   /   APPROPRIATE DATA
###FAMILY##/1234001234567/######################
```

After translation might appear:

```
EAA-NSN   /  PART-NSN   /   APPROPRIATE DATA
3210007654321/1234001234567/######################
4320008765432/1234001234567/######################
5430009876543/1234001234567/######################
```

(The illustration assumes that only three EAAs exist within this particular family.)

7.5.4.3 For pseudo-EAA codes, the translator program must refer to data lines within the program or to ancillary data files into which the major item NSN, PART-NSN, and all needed data have been placed. In this respect, the translator program serves as an unlimited extension of Sector 18 of the NSNMDR. Records created by the program should be "EAA-NSN/PART-NSN/APPROPRIATE DATA" as illustrated in paragraphs 7.5.4.1 and 7.5.4.2.

7.6 The balance of the data needed for a parts consumption computation must include, as a very minimum, the peacetime failure factor and the X-Factor. If the computation is to project peacetime consumption, the model explained in Appendix C should be used.

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7.7 Building the Computational File.

7.7.1 In building the computational file, the relationship of major item to part, the failure factor, and the X-Factor must be incorporated. In addition, other data elements will be included. Their purposes are explained in paragraphs 8 and 9.

7.7.2 This is envisioned as an effort to be carried out primarily at the MRC with file consolidation and fine tuning to be done at a central location.

7.7.3 The first step is to screen all NSNMDRs at each MRC. For each item, extract from the files of the CCSS the following data:

    National Stock Number (NSN)
    Class of Supply Code (CSC)
    Unit Price (UPRICE)
    Price Code (PRC)
    Financial Inventory Accounting Code (FIACD)
    Item Management Processing Code (IMPC)
    All EAA data from Sector 18

If the first position of the CSC is not equal to "7" or "9," ignore the record and advance to the next record. This screen picks up data for all parts ("9") and any possible hidden components ("7"). A screen on the unit price is optional; however, it could be used to control the file size.

7.7.4 The next step is to screen the relationship code and the essentiality code found in Sector 18. (See Figure 3.)

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```
S18 1 RELCD VRC ES BIL SRCD ML FAIL-1 FAIL-2 FAIL-3 QPEA  ISC EAA
    1 00000 001 1   00  PA FZ 000005 000005 111111 00012 N    EFFEAAEAS
```

Figure 3

SECTOR 18, NSN MASTER DATA RECORD

If the application is a substitution or if the application is not

essential, the data is to be ignored and advancement made to the next

application. For items which are CSC "7" or CSC "9" which are used in

prime applications and which are used in essential applications, build

the following record in a basic applications file for every EAA:

EAA-CD/PART-NSN/QPEA/SRCD/ML/FAIL-1/FAIL-2/FAIL-3/UPRICE/FIACD/IMPC/RIC

7.7.4.1 Legend of codes not previously identified:

BIL	Basic Issue List (Code)
EAA-CD	End Article Application Code
ES	Essentiality (Code)
FAIL-1	Peacetime Failure Factor
FAIL-2	Wartime Failure Factor
FAIL-3	Environmental Failure Factor
ISC	Initial Support Code
ML	Maintenance Level (Code)
QPEA	Quantity Per End Article (Code)
RIC	Routing Identifier Code
SRCD	Source Code

7.7.4.2 Note that the RIC would normally indicate the manager of

either the PART-NSN or the EAA, but here it does neither. It is the

RIC of the MRC from whose files the data was obtained. For example,

an RIC of "B64" in the preceding applications record would indicate

that the data in the record was obtained from the files of MICOM.
(See Figure 4.)

```
           ┌─────────────┐
           │  NSN        │
     ┌────▶│  MDR        │
     │     └──────┬──────┘
     │            │
     │            ▼
     │          ◇◇◇◇◇         Is the NSN a major item or
     │         ◇     ◇          a part?  If not, next record.
     │  NEXT  ◇       ◇        Is the application prime?  If
     │         ◇     ◇           not, next record.
     │          ◇◇◇◇◇         Is the application essential?
     │            │             If not, next record.
     │            │ YES
     │            ▼
     │      ╭───────────╮
     └──────│  BASIC    │
            │APPLICATIONS│
      NEXT  │   FILE    │
            ╰───────────╯
```
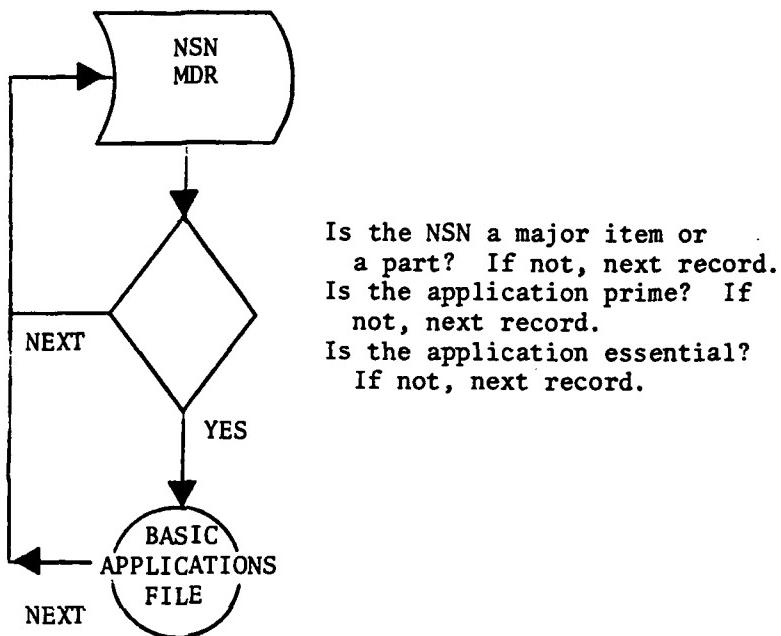
Figure 4

CREATION OF BASIC APPLICATIONS FILE

7.7.5 The next step is to apply the MRC-unique translator program

to the basic applications file. The RIC can be used as a key to assure

that the proper translator program is matched to the correct records

within the file. A decoded applications file must be created in which

each record appears exactly like those of the basic applications file

except that the EAA-CD has been replaced by the EAA-NSN to include NSN

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records for family groupings and pseudo-EAA codes; e.g.:

EAA-NSN/PART-NSN/QPEA/SRCD/ML/FAIL-1/FAIL-2/FAIL-3/UPRICE/FIACD/IMPC/RIC

The decoded applications file contains EAA-NSNs which are not major items as well as duplicate applications caused by data which were recorded in the files of the two MRCs. (See Figure 5.)

BASIC
APPLICATIONS
FILE

TRANSLATION
PROGRAM

NEXT

YES

Does RIC match RIC?
If not, next record.

REPLACE
EAAs WITH
NSNs

DECODED
APPLICATIONS
FILE
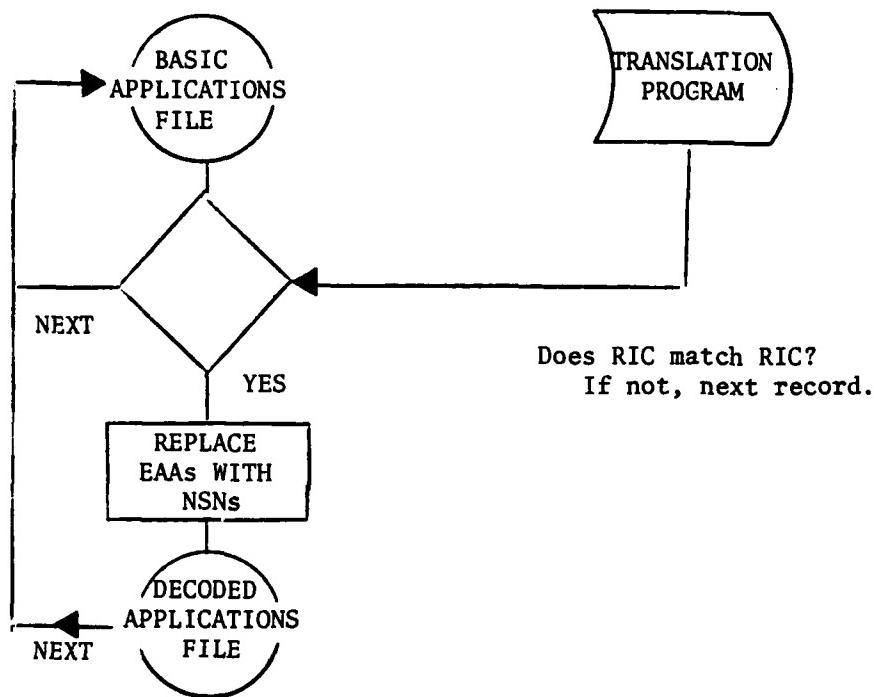
NEXT

Figure 5

CREATION OF DECODED APPLICATIONS FILE

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7.7.6 The next step consists of scrubbing out duplicate records and records of EAA-NSNs which are not major items. To do this, an SB 700-20 scrubber file must be prepared. Consolidated with this step is the insertion into the scrubber file of system X-Factors based upon increased usage, flying hour programs, rounds fired, tonnages moved, or whatever criteria may be most appropriate for determining X-Factor value.

7.7.6.1 Chapter 2 of SB 700-20 contains a listing of all LIN-related Army adopted items of materiel. Magnetic tape copies of this data may be obtained from the US Army Catalog Data Agency.

7.7.6.2 To build the SB 700-20 scrubber file, a tape copy of Chapter 2 records must be edited. If the first position (supply code) is not equal to "7," delete the record. This screen eliminates everything except major items from the file.

7.7.6.3 Next, the file must be edited to delete obsolete major items. If the logistics control code is not equal to "L," "A," or "B," delete the record. Normally, there is no interest in computing requirements for parts for the deleted items.

7.7.6.4 The appropriate X-Factor must now be added to each record. This can be done by NSN, LIN, or system as desired. It should be noted that if X-Factors are to be added by system, alpha codes can be used in lieu of X-Factors. The data processing program can then be written to allow easy maintenance and last minute update of the factors. For example, all major items within the HAWK weapon system can be coded "AA." Prior to a run, all "AA"" codes can be set to the proper numerical factor. (See Figure 6.)

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```
                SB
              700-20
              CH. 2


                                    IS CLASS OF SUPPLY EQUAL TO "7"?
                                        IF NOT, NEXT RECORD.

   NEXT                              IS LOGISTICS CONTROL CODE EQUAL
                                        TO "L," "A," OR "B"?
                                        IF NOT, NEXT RECORD.

                   YES

            ADD SYSTEM,
            LIN, OR NSN
             X-FACTOR


            SB 700-20
            SCRUBBER
   NEXT      FILE
```
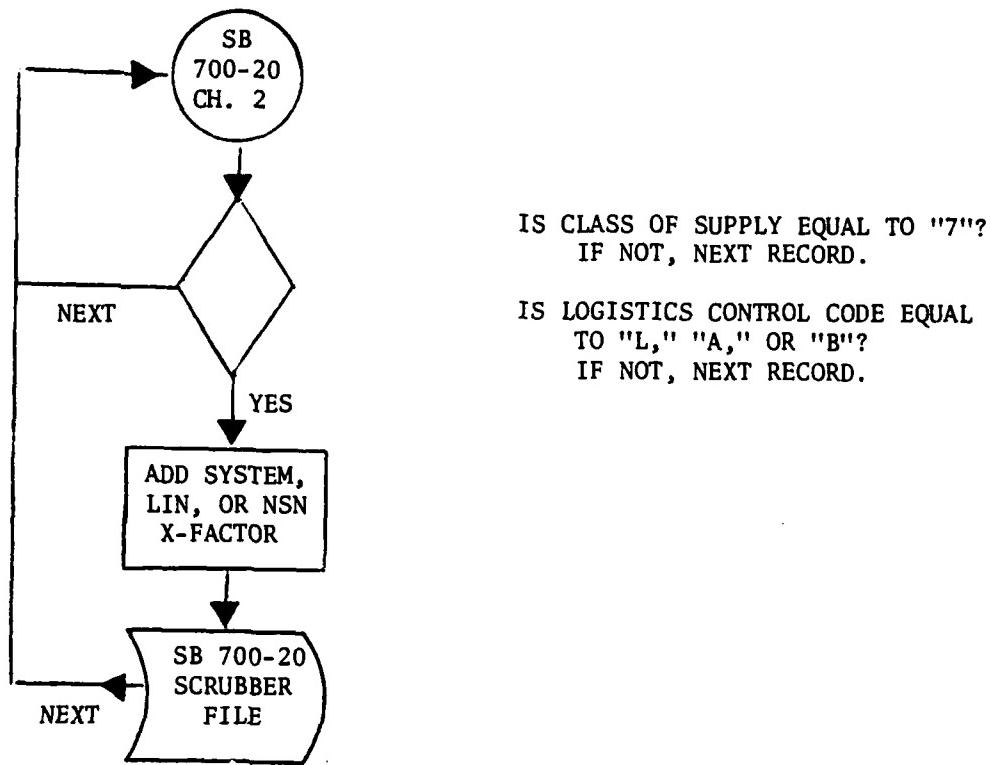
Figure 6

BUILDING THE SCRUBBER FILE

7.7.6.5 The result is a file of all currently used major items,

the routing identifier code of their managers, the item, LIN or system

X-Factors, and other data originally contained in SB 700-20. For

example:

MI-NSN/RIC/X-FAC/OTHER DATA

7.8 The process of scrubbing out unwanted data from the decoded applications file consists of matching major item NSNs from the SB 700-20 scrubber file to the EAA-NSN in the decoded applications file.

7.8.1 If no match is found for the EAA-NSN, delete the record. The application is an obsolete major item, an LIN-related secondary item or a next higher assembly type of EAA.

7.8.2 If the RIC of the major item manager (from the scrubber file does not match the RIC of the data-furnishing command (from the decoded applications file), delete the record. The deleted record was one created from the files of a command which does not manage the major item and is, therefore, a duplicate usage record.

7.8.3 The X-Factor appropriate to the NSN, LIN, or system is added, and a new file called the *scrubbed applications file* is created. This file almost meets the description of the computational file as stated in paragraph 7.7.1; however, it is not yet complete. (See Figure 7.)

7.9 Uniqueness exists in the way MRCs handle the parts for hidden components in their NSNMDRs. Some commands enter the parts for these hidden components; others do not. However, hidden components are source coded "PE" in Sector 18 and are readily identifiable. For commands which do not include parts for hidden components, data interchange must occur between the manager of the major item and the manager of the hidden component so that records showing the usage of the parts on the hidden components can be identified to the major item to which they apply. This task is a straightforward look-up of parts used by the hidden

Does application NSN match
    scrubber NSN?
    If no, next record.
Does RIC match RIC?
    If no, next record.
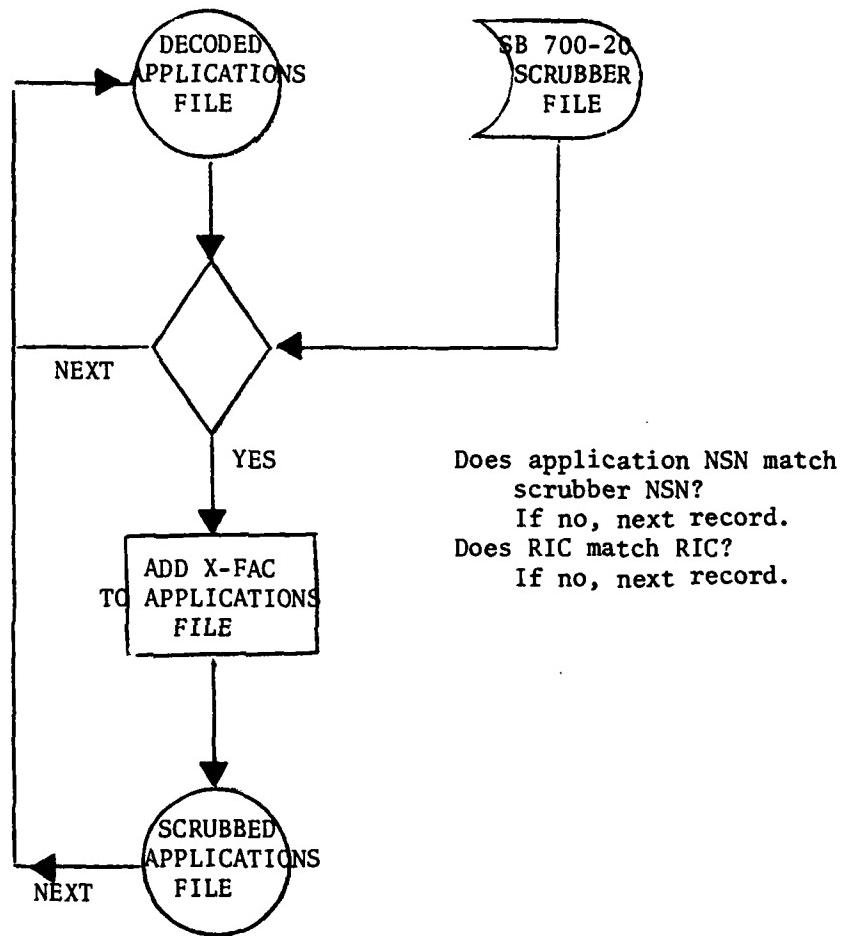
Figure 7

CREATION OF SCRUBBED APPLICATIONS FILE

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component in its major item role and a replacement of the hidden

component's NSN with the NSN of the major item of which it is a part.

Of course, if the files were consolidated in a central location prior

to this step, data interchange would be unnecessary; the assembled

file itself would contain sufficient data for this final step.

7.10 <u>The Complete Computational File</u>. The complete computational

file would have the following logical format:

MI-NSN/PART-NSN/QPEA/SRCD/ML/FAIL-1/FAIL-2/FAIL-3/UPRICE/FIACD/IMPC/
RIC/X-FAC

7.11 <u>The Streamlined Applications File</u>. Any sustainability simula-

tion in which this file is used will be sorely constrained by input/

output time as opposed to computation time. Therefore, it is suggested

that a precomputation *be effected so that the file is* reduced as follows

to form a streamlined applications file:

MI-NIIN /PART-NIIN /FAIL-1/PRE-COMPUTED WARTIME FACTOR
012345678/007654321/00004/00016

This record could be stored on the disk as 15 bytes of packed binary

data. If the simulation were run on a computer having an operating

system which could accept a 15,000 byte record, a blocking factor of 1,000

would result in each disc access picking up 1,000 records. It is estimated

that with the utmost streamlining, each timeframe of a sustainability simulation

may be run in less than an hour providing other facets of the program

are equally streamlined. Thus, real time answers can be obtained.

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7.12 <u>Streamlined Applications File with a Unit Price Cutoff</u>. The basic streamlined applications file must be limited to approximately one million records or real time processing cannot be achieved.

7.12.1 The profile of the parts inventory appears in Table 1. Note that as the UPRICE decreases the number of parts appear to increase exponentially. However, the applications in which the parts are used increase at an even faster rate. For example, a .01 microfarad capacitor (a button-like item with two wires extending from it which retails for about 15 cents) probably has application in at least half of the Army's major items. Therefore, for sustainability simulation there must be a cutoff UPRICE criterion or the file will become too large for real time runs. It is proposed that items having a UPRICE of $10 or less be excluded from the initial run. Subsequent adjustments to the UPRICE floor can be made to control processing time.

7.12.2 Low UPRICE items are often bench stock, have short procurement lead times (in contrast to expensive items), and lend themselves to substitution by maintenance personnel. For example, maintenance personnel can substitute two 33-Ohm resistors for one 66-Ohm resistor. Since such substitutions are never listed in interchangeability and substitutibility files, these actions cannot be successfully simulated. It is expected that excluding parts of low UPRICE will have a minimal adverse impact on sustainability projections.

7.13 <u>An Undesirable but Necessary Edit</u>. The Army has no readily available data base for asset positions of major items which are not

STRATIFICATION OF ESSENTIAL CLASS IX ITEMS

Unit Price Range in Dollars	Number of NSNs Falling into Each Range
.01 - 5.00	434177
5.01 - 10.00	91694
10.01 - 15.00	47627
15.01 - 20.00	32078
20.01 - 25.00	23791
25.01 - 30.00	18545
30.01 - 35.00	14440
35.01 - 40.00	12034
40.01 - 45.00	10310
45.01 - 50.00	8969
50.01 - 55.00	8280
55.01 - 60.00	6443
60.01 - 65.00	5851
65.01 - 70.00	5194
70.01 - 75.00	5119
75.01 - 80.00	4856
80.01 - 85.00	4293
85.01 - 90.00	3789
90.01 - 95.00	3657
95.01 - 100.00	3669
OVER 100.00	115251

Table 1

DATA DERIVED FROM THE ARMY MASTER DATA FILE AS OF OCTOBER
1979. INCLUDES ALL CLASS IX ITEMS WHICH ARE NOT CODED
AS UNESSENTIAL.

coded Reportable Item Control Code (RICC) "1" or "2." The streamlined computational file must necessarily undergo another edit to delete applications for non-RICC "1" or "2" major items. Although essential major items may share a few parts with other major items, it is believed that this will not be the cause for substantial inaccuracies in a sustainability forecast.

7.14 Closing Remarks About Building the Computational File. The logical sequence of file building and scrubbing, as depicted in this study, is used to facilitate understanding. In actual practice, it is most likely that programmers can include all steps except the last (parts for "PE"-coded hidden components) in one computer program. The programming task to implement the Study 905 methodology is very simple; it can be done quickly and readily debugged. However, one should also consider the data upon which the program must operate. If Sector 18 data is 95 percent accurate and complete and if the file consists of one million records, then 50 thousand records will be bad (an average of 10 thousand per MRC). To purify the file of so many errors represents a big workload.

8. Some Remaining Considerations.

8.1 Failure Factors.

8.1.1 Updating the FAIL-1 Factor. FAIL-1 is generally the original peacetime failure factor determined by maintenance estimates made during the initial provisioning process. However, Quantity Per End Article (QPEA) (as contained in the complete computational file) together with

historical major item program density data and average demand rate for the part (data readily available at the MRCs) will permit recomputation of FAIL-1 to bring this factor into alignment with actual demand. The recomputation may be accomplished in the following sequence: (1) determine the actual quantity of parts in use; (2) determine a failure rate per part; (3) multiply the failure rate per part by QPEA to arrive at FAIL-1 in its major item application; and (4) adjust the new FAIL-1 to reflect failures per 100 major items per year. If the proposition that parts wear out equally fast in every application is acceptable, then the process of updating FAIL-1 into a demand-based failure factor can be completely automated. If not acceptable, manual adjustments can be made and entered into the files using the previously addressed automated figures as a guide or the present factors can remain unchanged. The study does not address which course of action is most appropriate, but does offer the capability to update FAIL-1 as an advantage of building the computational file.

8.1.2 <u>Using FAIL-2 and FAIL-3 Rather than FAIL-1</u>. FAIL-1 and the X-Factor are normally used in computing requirements; however, there are parts which are liable to receive ruinous combat damage but have little or no peacetime demand. In such instances, the use of FAIL-2 (wartime factor) and FAIL-3 (environmental factor) is more appropriate. Requirements objectives for such parts usually contain a numerical stockage objective and the Item Management Processing Code (IMPC) normally indicates this fact. However, the IMPC applies equally to

all applications of a part; whereas, the use of FAIL-2 and FAIL-3 may not be appropriate to every application. Due to the lack of a better code upon which to select, the complete computational file lists the IMPC. If the IMPC identifies an item has having a numerical stockage objective, the parts requirements should be computed using FAIL-2 and FAIL-3 in lieu of FAIL-1. (See paragraph 10.3.1 for a suggested way to correct this deficiency.)

8.2 The "Spares Dilemma."

8.2.1 With respect to spares, both peacetime and wartime factors are used to calculate that quantity of items which become unserviceable, uneconomical to repair. There is at present no identified methodology for forecasting total unserviceable spares (both economical and uneconomical to repair). This leads to the conclusion that in a sustainability simulation a forecast of deadlined major items will be correct only if the assumptions of paragraph 5.1 and 5.2 are correct.

8.2.2 The computational file relates parts directly to major items. Use of such a relationship is excellent for requirements computation; however, for a major item sustainability simulation, requirements are best computed "top-down." In Figure 8 if spares are in long supply, repair parts are in normal supply and the usual method of computing requirements is used, an inaccurate sustainability forecast may result. When a shortage of repair parts exists, the major item will become deadlined-NORS in spite of the availability of adequate spares.

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```
        ┌─────────────────┐
        │ MAJOR ITEMS     │
        │ (VEHICLES)      │
        └─────────────────┘
                 │
                 ▼
        ┌─────────────────┐
        │ SPARES          │
        │ (ENGINES)       │
        └─────────────────┘
                 │
                 ▼
        ┌─────────────────┐
        │ REPAIR PARTS    │
        │ (IGNITION POINTS)│
        │ FOR ENGINES)    │
        └─────────────────┘
```
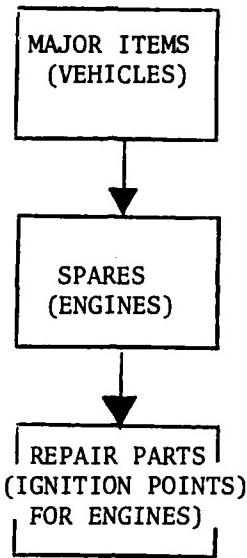
Figure 8

"TOP-DOWN" REQUIREMENTS COMPUTATION

However, if requirements for spares were calculated first, followed
by subtraction of serviceable assets, and then requirements for repair
parts calculated based upon unserviceable spares, the results would be
more appropriate to a sustainability simulation. Not only is the data
for this type of computation not reaily available, but use of a compli-
cated algorithm in connection with an assumed one million records would
likely preclude real time forecasting. Furthermore, additional data
would be required in each record resulting in an increase in processing
time.

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9. Other Potential Uses of the Computational File.

9.1 Stockage Lists. Maintenance Levels (ML) have been included in the complete computational file so that the file may be used in the computation of Prescribed Load Lists (PLL), data on supported makes and models of major items being available from TAEDP. Authorized Stockage Lists (ASL) can also be produced based upon the major items in supported units. By varying the computation formula, lists for both peacetime and wartime can be prepared by machine.

9.2 Budgetary Documentation. The unit price and the financial inventory code have been included to permit use of the file in preparation of budgetary documentation. The file can be used in conjunction with the Standard Study Number System to roll up parts requirements and dollars into the same categories into which the major items themselves are summarized.

9.3 Transportation Requirements. It is further noted that if weight and cube are included in the complete computational file, certain Class IX transportation requirements could also be computed.

10. Summary of Findings. This section briefly outlines the findings of the study and refers the reader to the appropriate section/paragraph of the report for details. This is considered appropriate since the format of the study is "how to" rather than "should we?" or "can we?".

10.1 Advantages Accruing if the Study 905 Methodology is Implemented.

10.1.1 A Class IX requirements computation can be done *by weapon system/major item* in real time for support of crisis management systems

such as Logistics Data Network (LOGNET) (paragraph 7.11 through 7.12.2).

10.1.2 Peacetime failure factors for Class IX items can be updated to reflect actual demand history using automatic data processing equipment either exclusively or in part (paragraph 8.1.1).

10.1.3 ASLs and PLLs for Class IX items can be computed for both peacetime and wartime (paragraph 9.1).

10.1.4 Class IX budget requirements, both item quantities and funds needed, can be computed by major item/weapon system (paragraph 9.2).

10.1.5 Class IX transportation requirements could be forecast (paragraph 9.3).

10.2 Disadvantages of the Study 905 Methodology.

10.2.1 Class IX requirements are based on factors which relate parts directly to the major item upon which they are used. Although this is the preferred methodology for computation of requirements for stockage purposes, it is not as realistic as a "top-down" computation as far as sustainability simulations are concerned (paragraph 8.2 through 8.2.2).

10.2.2 Use of the IMPC as a *factor selection code* can result in the inappropriate use of wartime failure factors (paragraph 8.1.2).

10.3 Problems.

10.3.1 There is presently no suitable *factor selection code* in Sector 18 of the NSNMDR. This could be "1" if use of the peacetime factor is more appropriate and "2" if use of the wartime factor is more appropriate. Other numbers could be reserved for future expansion.

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This code can vary by application (see paragraph 8.1.2) and should, therefore, be included at the RELCD level. Equally satisfactory is a location in the 13th position of the space currently used for the EAA code if this space is not in use by any MRC.

10.3.2 At the present time, most interest is being exhibited toward sustaining major items with adequate supplies of spare and repair parts. After deployment of systems to simulate this, the next question will become "are there sufficient maintenance skills and manhours to use the available spares and repair parts?". Data concerning replacement time for spares and repair parts and data concerning the time required to repair unserviceable spares themselves are collected and used in the preparation of maintenance allocation charts. This maintenance time data is a prime candidate for inclusion in Sector 18 where it would be available for simulation purposes at some future time. The following data should be included in Sector 18 at the RELCD level:

> Time needed for overhaul of a reparable.
> Time needed for repair of a spare.
> Time needed to replace a failed Class IX item or hidden
> component in a major item.

11. Recommendations.

11.1 If approved, the next steps are development of functional specifications, a cost/benefit analysis, and a resource requirements estimate for implementation.

11.2 Unresolved problems, paragraph 10.3, can be remedied by submission of Systems Change Requests to US Army Automated Logistics Management Systems Activity (ALMSA).

APPENDIX A

GLOSSARY

End Item Density - The average number of an essential major item "in use" (as opposed to "in storage") during a specific period of time.

Essential Major Item - A major item with a reportable item control code of either "1" or "2."

Failure Factor (Peacetime) - The number of Class IX items failing per hundred major items per year. In the context of this study, the failure factor is the factor determined by maintenance managers prior to the initial provisioning process as opposed to a "demand-based" failure factor resulting from experience after fielding.

Hidden Component - A major item per se, but one which is used as a component within a larger, stock-numbered assembly (e.g., the M113 armored personnel carrier chassis hidden within the major item, Lance Launcher, Carrier-Mounted). However, if a component major item is separately authorized or reported, it is not a "hidden component."

Intensity Factor - A factor furnished by OSD/DA guidance to relate consumption to a war scenario. A factor of 1.00 indicates the most intensive equipment usage during wartime (100% of forces committed), while a value of .67 is considered "normal" wartime usage (67% of forces committed, 33% in reserve). This factor is subject to variation during the timeframes of the scenario or planning period.

Major Item - Any item listed in Chapter 2 of Supply Bulletin 700-20 with Class of Supply Code equal to "7."

Parts - This term is used in the study to facilitate readability. Items with Class of Supply Code "9" are categorized in two different ways depending on the purpose of the categorization. The first method separates class "9" items into "consumables" versus "reparables"; this categorization is used in wholesale item management. The second method separates class "9" items into "spares" versus "repair parts"; this categorization is used for the purpose of property accountability, direct exchange and provisioning. Subclasses:

Consumables - Items with Class of Supply Code equal to "9" which either cannot be repaired when they become unserviceable (e.g.,

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automotive ignition points) or which can be completely repaired or condemned by the user or the DS/GS level (e.g., automotive carburetor). Once consumables have been issued by the wholesale manager, they are normally never returned to wholesale stock.

Repair Parts - Class IX items which, when they become unserviceable, are normally salvaged (e.g., the automotive ignition points previously classified as consumable).

Reparables - Items with Class of Supply Code equal to "9" which have been coded for overhaul at CONUS depots or special repair activities. Lower echelon activities may repair some malfunctions, but they lack the capability to repair all failures. Once reparable class items have been issued, the wholesale manager expects to fill part of his future requirements with items which will be returned and overhauled.

Spares - Class IX items which, when they become unserviceable, are to be repaired at some level (e.g., the automotive carburetor previously classified as a consumable).

Period - The number of days in a time frame of a war scenario or in a support period.

X-Factor (X-FAC) - The ratio of the most intense wartime equipment usage (hours, miles, rounds fired, etc.) to normal peacetime usage. For example, if X-FAC for a truck is "3" and if the truck wears out one fan belt per year in normal peacetime usage, a quantity of three fan belts per year will be required during most intense wartime usage. X-Factors, as applied to Class IX items, may be identified either as "commodity" X-Factors when one factor is used for all applications of a multi-application Class IX item or as "system" X-Factors when the factor varies for each different weapon system in which a Class IX item has an application.

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APPENDIX B

LIST OF ACRONYMS AND ABBREVIATIONS

ALMSA	US Army Automated Logistics Management Systems Activity
AMDF	Army Master Data File
ASL	Authorized Stockage List
BIL	Basic Issue List (Code)
CBS-X	Continuing Balance System - Expanded
CCSS	Commodity Command Standard System
CSC	Class of Supply Code
DA	Department of the Army
DARCOM	US Army Materiel Readiness and Development Command
DESCOM	US Army Depot Systems Command
EAA	End Article Application
EAA-CD	End Article Application Code
EAA-NSN	End Article Application - National Stock Number
ES	Essentiality Code
FAIL-1	Peacetime Failure Factor
FAIL-2	Wartime Failure Factor
FAIL-3	Environmental Failure Factor
FIACD	Financial Inventory Accounting Code
IMPC	Inventory Management Processing Code
ISC	Initial Support Code
LIN	Line Item Number

LOGNET	Logistics Data Network (for Army Crisis Management)
LSO	Logistics Studies Office
MI-NIIN	Major Item - National Item Identification Number
MI-NSN	Major Item - National Stock Number
MICOM	US Army Missile Command
MILSTRIP	Military Standard Requisitioning and Issue Procedures
ML	Maintenance Level
MRC	Materiel Readiness Command
NORS	Not Operationally Ready - Supply
NSN	National Stock Number
NSNMDR	NSN Master Data Record
OSD	Office of the Secretary of Defense
PART-NIIN	Part - National Item Identification Number
PLL	Prescribed Load Lists
PRC	Price Code
QPEA	Quantity Per End Article
RELCD	Relationship Code
RIC	Routing Identifier Code
RICC	Reportable Item Control Code
SB 700-20	Supply Bulletin 700-20, Army Adopted/Other Items Selected for Authorization/List of Reportable Items
SB 710-1-1	Supply Bulletin 710-1-1, Standard Study Number System
SRCD	Source Code
SSN	Standard Study Number
TARCOM	US Army Tank-Automotive Readiness Command

TAEDP	Total Army Equipment Distribution Program
TLR/S	Total Logistics Readiness/Sustainability
UPRICE	Unit Price
X-FAC	X-Factor

APPENDIX C

MODEL FOR COMPUTATION OF CLASS IX CONSUMPTION FOR A TOTAL FORCE

The model displayed and explained in paragraphs 6.1 and 6.2 computes consumption for forces in combat. It is repeated here:

$$\text{Consumption}_{(Combat)} = EFTXI$$

Where E = End Item Density
       F = Peacetime Failure Factor
       T = Time Interval
       X = X-Factor
       I = Intensity Factor

The following model computes consumption for forces not in combat (using peacetime rates):

$$\text{Consumption}_{(Peace)} = EFT$$

This second model is also applicable to that portion of equipment in a war theater which is in hands of those units held in reserve. Refer to Appendix A, Glossary, for a definition of the Intensity Factor.

Both models may be algebraically combined as follows:

$$\text{Consumption}_{(Total)} = EFT \, [XI + (1-I)]$$

Where $0 \leq I \leq 1$

This third model may be used universally.

Consumption of parts for those items in reserve is computed at peacetime rates and is computed at wartime rates for items committed to combat.